ALUMINUM

Project Fact Sheet

Integrated Numerical Methods and Design Provisions for Aluminum Structures

Benefits

Approximately 2.7 billion pounds of aluminum extrusions are consumed annually in the U.S. One half of these applications are influenced by structural considerations. Improved structural efficiency can reduce weight by an average of 6 percent, resulting in a savings of 81 million pounds of aluminum per year. The resulting savings include an estimated $145.5 million in material costs, 3.15 billion kWh energy, and reduction of carbon dioxide emissions by 1.5 billion pounds.

Applications

This approach holds promise for aluminum members with irregular shapes, typical in extrusions, and cold-rolled members. It applies numerical analysis to determine local, distortional, and lateral buckling stresses for all types of sections and uses these buckling stresses to calculate capacities within the framework of the *Specifications*. The technical feasibility of the approach has already been proven for cold-formed steel members. Preliminary studies using the proposed approach suggest that axial and bending compressive strengths could be increased on the order of 6 to 12% by varying the web thickness.

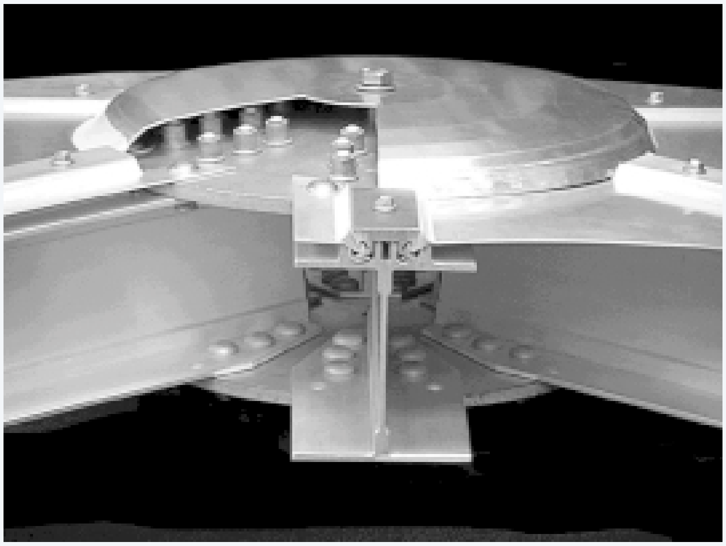
Tools being developed to calculate load carrying capacity and stiffness of aluminum sections.

Aluminum's competitive edge arises from the ease with which shapes can be extruded. Yet, this advantage cannot be fully exploited by designers because they do not have the tools to predict the strength of many extrudable shapes.

Suggested specifications for the structural design of parts made of various aluminum alloys were developed in 1962 and published in 1967 in *Specifications for Aluminum Structures* (Aluminum Association). The document has been revised five times, most recently in 1994, but methods for determining the buckling strength of extrusions are essentially unchanged. Many types of stiffeners, such as web stiffeners and multiple intermediate stiffeners, thickness changes and other cross-sectional peculiarities cannot be addressed by the current specification even though they add significantly to the load carrying capacity.

Researchers from Cornell University will develop and demonstrate a design methodology using finite strip analysis. It will result in design rules applicable to many extrudable or cold-rolled shapes. Columns, beams, and beam columns will be studied. A wide variety of failure modes such as local, distortional, torsional, torsional-flexural, and lateral buckling will be researched. Failures involving the interaction of these modes -- such as the local and overall buckling -- will be included in the study as well.

Aluminum Design Improvements



Integrated numerical methods and design provisions will enable more efficient design of aluminum shapes, such as the cut-out of a long span aluminum dome shown above.

Project Description

Goals: The goal of the project is to develop integrated numerical methods for analysis and robust design of aluminum structures. The types of structures to be covered include those used in the building, bridge, automotive, and other transportation industries. Parametric studies using numerical analysis and physical tests will include types of members and sections that are used or likely to be used. This project responds to *Aluminum Industry Technology Roadmap* objectives in the Finished Products Sector and in particular in needs to “develop integrated numerical methods for analysis and robust design of product, process and material.”

Progress and Milestones

Year One

- Flexural member tests will be carried out on selected types of members. These tests will likely be two-point load beam tests with bracing to exclude lateral buckling, followed by tests on laterally unbraced beams.
- Finite elemental studies will be carried out on the tested specimens to determine the accuracy of the simulations.

Year Two

- Thin-walled flexural members will be studied, particularly members in the post buckling range. Lateral buckling of rather irregular shapes that are common in extrusions will also be studied.

Year Three

- Column design provisions will be formulated.
- Final recommendations will be prepared for the incorporation of the developed procedures into the *Specifications* and/or design guide.

Commercialization Plan

The results of this project will be widely publicized to the aluminum industry across the U.S. The recommendations will be prepared for incorporation in the *Specifications for Aluminum Structures*. In addition, the recommendations and research findings will be incorporated into short courses and seminars to be held throughout the U.S.

Project Partners

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